# TL-922 Revival$_{(tm)}$

# Kenwood TL-922 Linear Amplifier Hardware Upgrade Kit

**Installation Manual**

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Beavercreek, Ohio 45434
14 March, 2015
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# *Thank-You!*

At Kessler Engineering, we endeavor to make your ham radio hobby more enjoyable and trust that our products will bring you many years of faithful service. We ***Thank-You*** for the confidence that you have placed in us and in our products. *73!*

Dr. Donald J. Kessler, Ph.D.,
President, Kessler Engineering, LLC

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# Caution!

## 1.1 You May Be Killed!

The Kenwood TL-922 Linear Amplifier contains ***LETHAL*** high voltages!!

One must be absolutely careful and fully understand the consequences of working on this amplifier. IF you come into contact with any of these High Voltages – *YOU MAY BE KILLED!!*

*PLEASE!* – We graciously request that you return the hardware upgrade kit to Kessler Engineering for a full refund (including postage) if any of the following apply:

- You are not comfortable working on this amplifier
- You are not qualified to perform this work
- You do not fully understand the potential hazards
- You no longer wish to perform these upgrades
- You are unable to solder
- You lack proper tools, etc.
- You've changed your mind, etc.

If for any reason you wish to return this upgrade kit, please do so. We will refund your purchase and shipping costs, ABSOLUTELY NO QUESTIONS ASKED! This is a hobby – it isn't worth losing one's life over.

# Introduction

## 2.1 General Description and Purpose

The Kenwood TL-922/TL-922A is a relatively low-cost HF linear amplifier with outstanding ergonomics. These amplifiers were constructed with high-quality components, in a form-factor that is attractive, functional, and unobtrusive. Unfortunately that original design (now 30+ years old) included a number of design shortcomings, some of which were detrimental to the amplifier's operation and longevity.

Over the years, a number of excellent articles have been written, such as those published by AG6K [3]-[7], that highlighted many of these problems and provided very good solutions. By applying these solutions, the amplifier's shortcomings may be eliminated and its overall operation and longevity greatly enhanced. In short, a properly modified TL-922 is a very reliable amplifier that will provide many years of flawless service.

A problem not always easily overcome by those seeking to perform these upgrades, is exactly how and where to implement them as well as where to find appropriate sources of parts. Another complication arises when one attempts to service a modified amplifier, particularly if modified by someone else. Depending upon the modifier's competency, willingness to document, and overall "neatness", troubleshooting such an amplifier can become a daunting task. Kessler Engineering LLC has overcome these challenges for you by making the process of upgrading the TL-922 amplifier much more practical, affordable, and serviceable.

Throughout this document, TL-922 will be used interchangeably to refer to both the TL-922 and the TL-922A linear amplifiers. The TL-922 and TL-922A are (almost) identical and these upgrades apply equally to both amplifiers. The TL-922 was sold throughout the World as a 160m-10m linear amplifier. However, 10m operation was disabled at the factory in order to permit importation into the United States, hence the TL-922 and TL-922A variants. Although a stock TL-922A will not operate on 10m, all of the components necessary for 10m operation were installed in the "A" variant and 10m operation may be enabled by removing a mechanical stop on the bandswitch and minimal rewiring of the 10m tuned input network.

## 2.2 Shortcomings in the Stock TL-922

TL-922 in its stock configuration has a number of impairments that adversely affect its operation and longevity. Some of these include:

1. Parasitic Oscillation
2. Excessive Filament Voltage
3. High Voltage / High Current PTT Switching
4. Excessive In-Rush Current
5. Loud, Hot-Switching T/R Relay
6. Slow, relay-controlled tube bias
7. Non-QSK
8. Meter lamps that are no longer available

The most significant problems which require immediate attention are items 1 and 2, the amplifier's tendency to oscillate and its excessive filament voltage. Both of these problems are well described and resolved via an upgrade kit already available from AG6K[8]. If left uncorrected, these problems greatly affect amplifier reliability resulting in premature failure of the 3-500Z vacuum tubes which are increasingly expensive.

## 2.3 TL-922 Revival$_{(tm)}$ Hardware Upgrade Kit Features

Kessler Engineering's TL-922 Revival$_{(tm)}$ hardware upgrade kit provides:

1. Step-Start In-Rush Current Protection
2. Low-Voltage PTT Switching for use with modern solid-state transceivers
3. Quiet T/R Switching
4. QSK Operation
5. Electronic Bias Control
6. LED "On-Air", "Standby", and Meter Illumination

The upgrade kit utilizes four high-quality, removable circuit boards, with complete documentation to facilitate installation, service and maintenance of the modified TL-922 amplifier. The kit comes with all circuit boards assembled and tested. Should a fault develop on any of these circuit boards, it may be removed and serviced. If necessary, they may also be returned to Kessler Engineering for repair.

The complete modification kit comes with the items listed in Table 2.1 and shown in Figure 2.1.

Table 2.1: TL-922 Revival$_{(tm)}$ Modification Kit Contents

| Quantity | Description |
|---|---|
| 1 | LED Circuit Board |
| 1 | Step-Start Circuit Board |
| 1 | QSK T/R Relay Circuit Board |
| 1 | Electronic Bias Circuit Board |
| 1 | Wiring Harness |
| 8 | Heat Shrink Tubing |
| 12 | Plastic Wire Ties |
| 2 | 8mm Hex Nuts |
| 2 | Flat Steel Washers |
| 2 | Flat Nylon Washers |
| 1 | Rubber Grommet |
| 1 | LED Diffuser Paper |

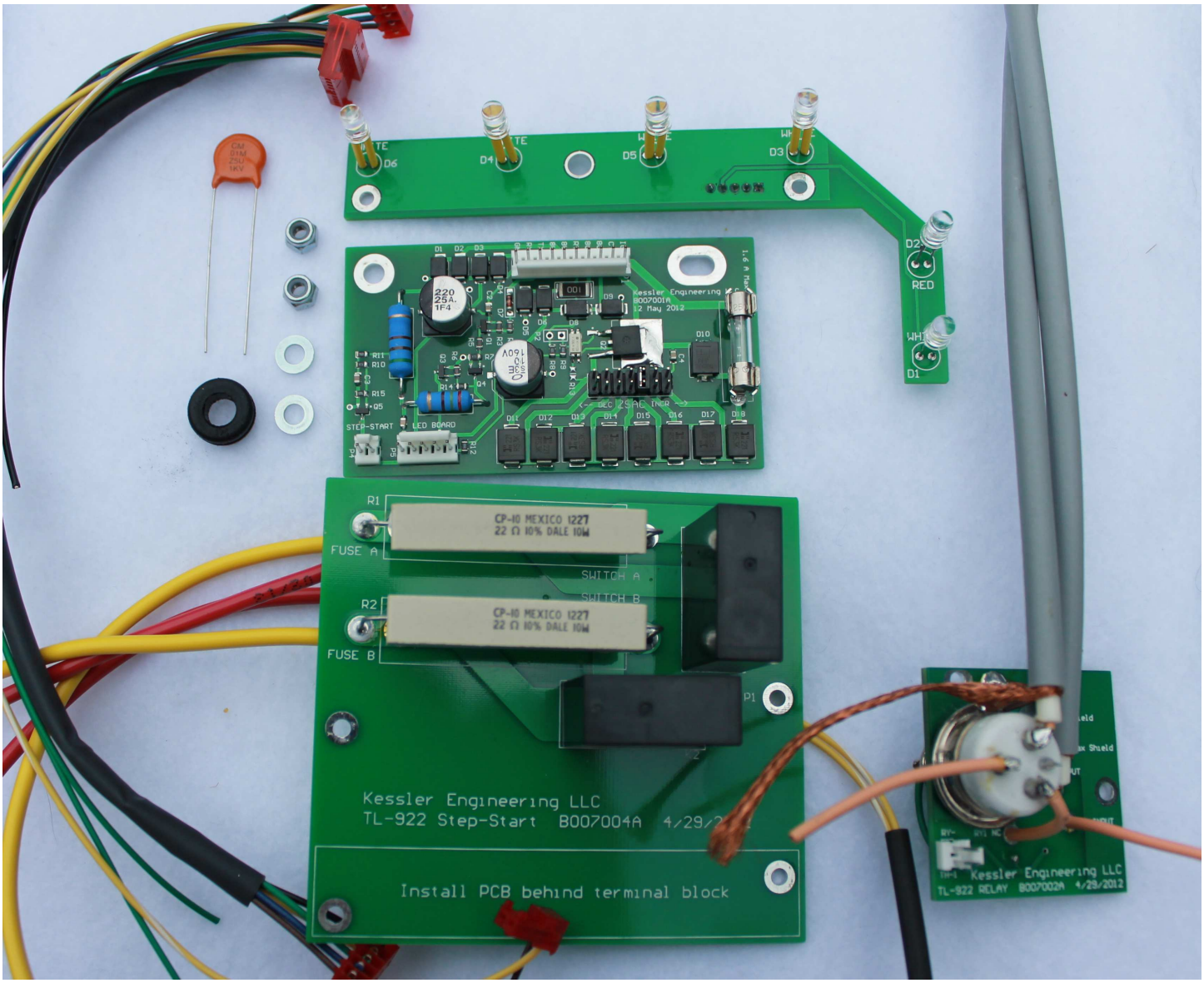


Figure 2.1: TL-922 Revival$_{(tm)}$ Upgrade Kit Contents

## 2.4 Preparation

We **highly** suggest performing these modifications on a fully functional amplifier. If the amplifier is non-functional, we suggest repairing the damage (if appropriate) before commencing the modifications. Problems due to a defective T/R relay, shorted Zener bias diode, defective bias relay, inoperative meter lamps, etc., may be ignored since these components are removed and discarded during the modification process. However, other problems such as defective tubes, bad high-voltage power supply, etc., will not be cured by merely installing this modification kit and should be resolved first.

The TL-922 Instruction Manual [1] and the TL-922 Service Manual [2] are excellent reference documents and one should consult them and become very familiar with the electrical as well as mechanical layout of the amplifier prior to performing any work on the amplifier. Copies of these manuals are available from various sources on the Internet, quite often as a cost-free download.

The hardware upgrade kit entails installation of four printed circuit boards (PCB), making connections to those circuit boards and soldering to various components within the amplifier. Before these PCBs can be installed, the amplifier must be partially disassembled (not that daunting), and a number of components and assemblies removed from the amplifier.

The four circuit boards to be installed are:

- LED – Front Panel Display and Meter Illumination
- QSK – T/R Relays
- Step-Start – AC Mains Current Limiting
- Electronic Bias – Control of tube Bias, Step-Start, QSK, LED, and Soft-Switching.

### 2.4.1 Tools Required

- #2 Phillips Head Screwdriver
- #2 Right-Angle Drive Phillips Head Screwdriver
- Wire Cutters
- Wire Strippers
- Small Needle-Nose Pliers
- Small Vise-Grip Pliers

- 8mm Socket
- 5mm Hex Key (Allen Wrench)
- Soldering Iron and Solder
- Solder Wick or Solder Sucker
- Volt-Ohm Meter
- Heat Gun

**CAUTION!** Modification of the TL-922 amplifier requires desoldering and soldering of numerous components and connections, any of which are prone to damage if subjected to excessive heat or physical force. Please use caution.

**WARNING!** ALL electrical power must be removed from the amplifier! No Exceptions! Under no circumstances should the amplifier be plugged into electrical power, switched *On*, etc., while performing any of these modifications.

- Unplug the amplifier from the AC mains supply!
- Disconnect all other electrical connections to the amplifier.
- Wait at least 30 minutes after removing AC Mains power before removing any covers from the amplifier.
- Remove the amplifier outer and inner top covers.
- visually inspect (but do not touch) the high-voltage safety switch (shorting strap) and ensure that it is properly engaged.

## 2.5 LED Board Installation

### Synopsis

The amplifier's incandescent lamps will be removed and replaced with a PCB containing six LEDs which provide meter illumination as well as "Standby" and "On-Air" status indications.

### Installation

The stock lamps are held in-place by rubber grommets and electrically connected to a terminal strip as shown in Figure 2.2.

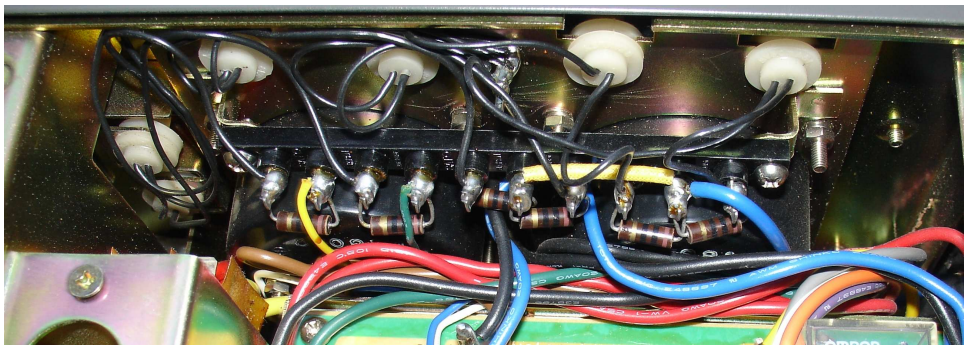

Figure 2.2: Stock Lamps Prior to Removal

- Remove and discard the meter lamps by sliding them upward.
- Remove and discard the "Standby" and "On-Air" lamps, sliding them sideways (as necessary).
- Remove (but retain) the two screws holding the terminal strip. *Note:* We suggest using a right-angle drive screwdriver.
- Cut (as necessary) any wire connected to the terminal strip.
- Remove and discard the terminal strip and lamps.

When finished, the lamp area should appear as shown in Figure 2.3.

- Orient the LED PCB, aligning the PCB mounting holes over the mounting brackets used to hold the terminal strip.
- Place plastic insulating washers behind the PCB attachment holes and then Attach the LED PCB using the two screws removed previously.

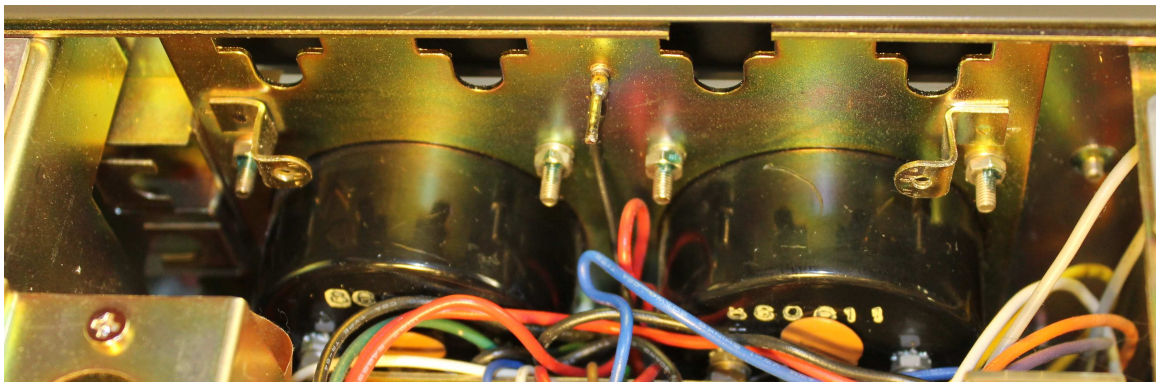

Figure 2.3: Panel with Illumination and Status Lamps Removed

- Check the orientation of the four illumination LEDs (D3, D4, D5, D6) – They should point downward toward the meters. Orient as necessary.
- Refer to Figure 2.3. There is an opening in the metalwork immediately above the "On-Air" lamp which provides access to the area directly over the top of the meters. Cut an $\approx$ 1.25in by 5in strip of the white diffuser paper and insert the paper strip into this opening, between the meter illumination LEDs and the meters. Inserting this "Diffuser" will provide uniform illumination of the meters and prevent bright spots.
- Check the orientation of the "On-Air" and "Standby" LEDs – They should point toward their respective "On-Air" and "Standby" plastic filters. Adjust as necessary.
- Route the wire bundle and electrical connector downward next to the bulkhead so that the connector emerges behind the "Stby-Operate" mode switch.

  **NOTE:** Later versions of the LED Circuit Board do not have wires soldered directly to the circuit board. Instead, they have a 5-Pin connector for easier installation and removal. In this case, connect either end of the cable provided into connector "P1" and route the wiring as shown in the Figure.

When finished, the installed LED board should look as shown in Figure 2.4.

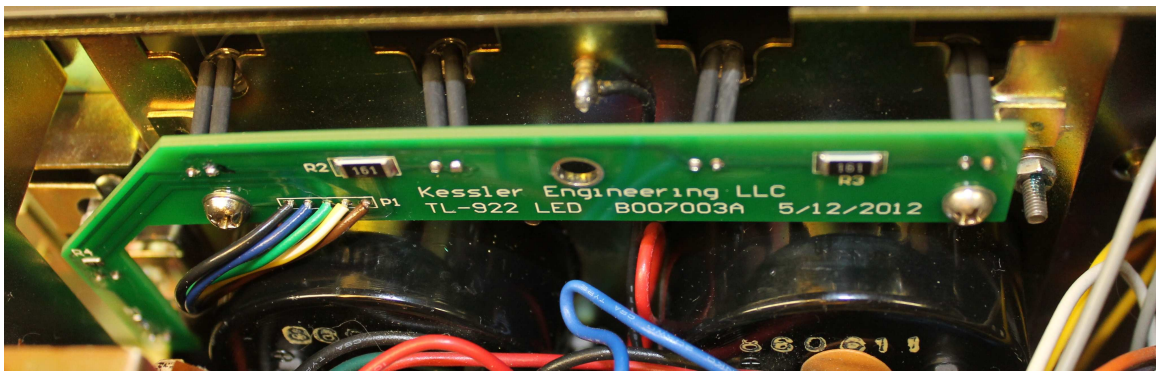


Figure 2.4: LED Circuit Board Correctly Installed

## 2.6 Step Start PCB Installation

### Synopsis

The rear fan enclosure will be temporarily removed for installation of the Step-Start PCB. The fuse holders will be re-wired to place the Step-Start circuit in series with the AC Mains fuses and the front-panel *On-Off* switch.

### Installation

- Remove the four screws holding the fan enclosure (Figure 2.5).
- Remove the enclosure, exposing the mains-adjustment terminal strip (Figure 2.6).
- Be careful not to strain the cooling fan wires.

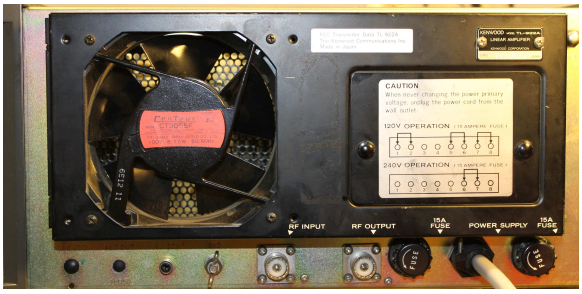


Figure 2.5: Rear Fan Enclosure

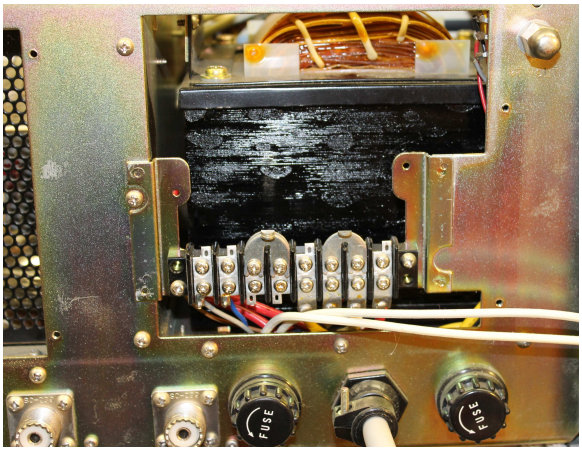


Figure 2.6: Mains Voltage Selection Terminal Strip

- Remove the two Phillips-Head screws holding AC Mains voltage selection black terminal strip.
- Insert the Step-Start PCB between the terminal strip and chassis.
- Route the wires as shown in Figure 2.7.

  Route the two #14 yellow wires downward past the right-most fuse holder.

  Route the two #14 red wires downward past the left-most fuse holder.

  Route the #22 twisted pair (and its 2-pin receptacle) downward near the SO-239 RF Output connector then, toward the front of the amplifier.

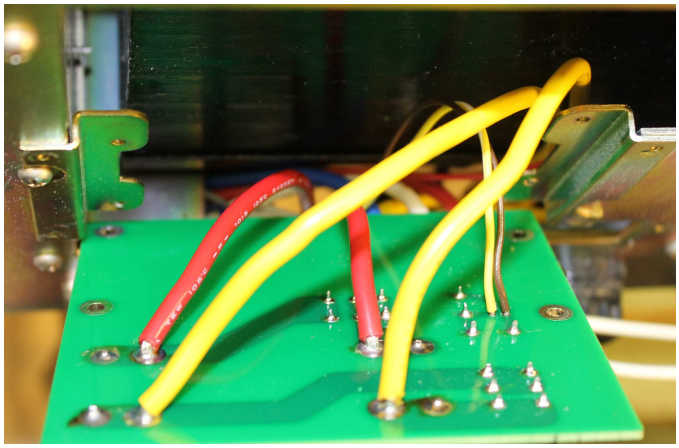

Figure 2.7: Inserting Step-Start PCB and Routing Wire Leads

- Re-install the terminal strip over the top of the Step-Start PCB using four two Phillips-Head screws. *Note:* Occasionally due to variations in the TL-922 metalwork, the mounting hole may be a snug fit. If necessary the mounting holes may be very slightly elongated.

The installed Step-Start PCB should appear as shown in Figure 2.8.

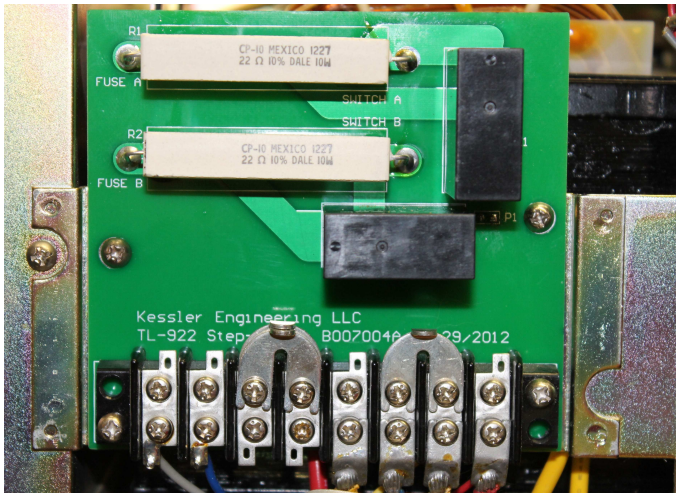


Figure 2.8: Step-Start PCB and Terminal Strip Orientation

- Re-install the fan enclosure (Figure 2.5).
- Remove both AC Mains fuses and set aside.
- Set the amplifier upside down.

The stock, unmodified AC mains fuse holders are shown in Figure 2.9.

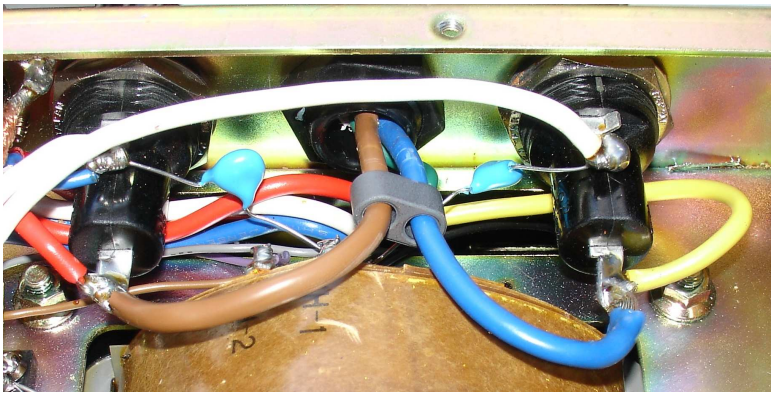

Figure 2.9: Stock Fuseholder Configuration

- With the amplifier and fuse area oriented as shown in Figure 2.9, de-solder and remove the white #14 wire emerging from the upper terminal of the left fuse holder.
- Solder either one of the #14 red wires emanating from the Step-Start PCB to the upper terminal of the left fuse holder.

- Solder together the free end of #14 white wire to the other #14 red wire and insulate with Heat-Shrink tubing.
- De-solder and remove the white #14 wire emerging from the upper terminal of the right fuse holder.
- Solder either one of the #14 yellow wires emanating from the Step-Start PCB to the upper terminal of the right fuse holder.
- Solder together the free end of #14 white wire to the other yellow wire. Insulate with Heat-Shrink tubing.
- Route the #22 twisted wire pair and connector from the Step-Start PCB up and into the amplifier toward the filament transformer.

When finished with this step, the results should appear as shown in Figure 2.10.

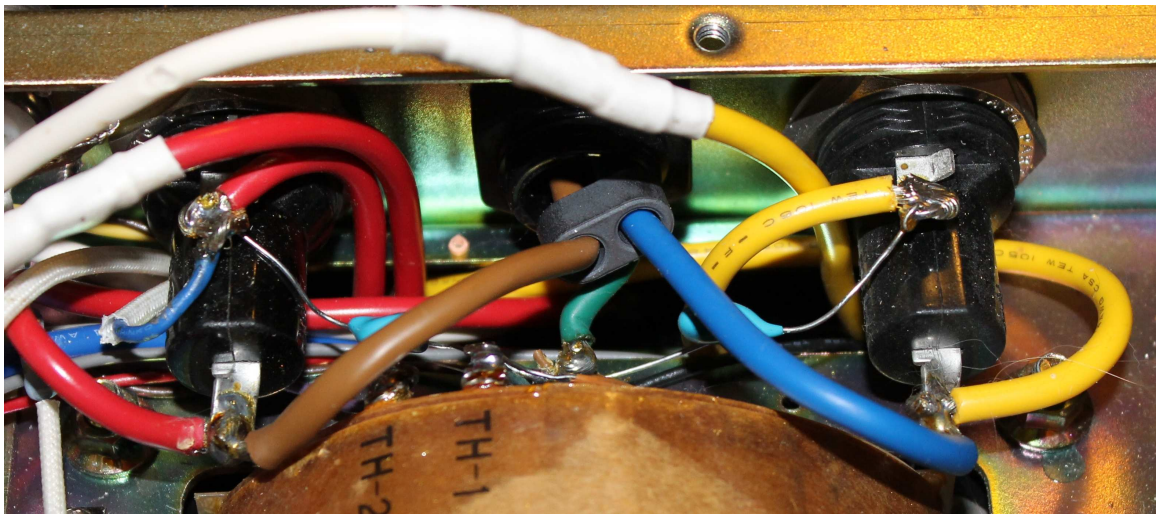


Figure 2.10: Step-Start to Fuseholder Connection

## 2.7 QSK T/R Relay PCB Installation

### Synopsis

The stock amplifier's bias relay, T/R relay, and coaxial cables will be removed and discarded. The QSK T/R Relay PCB (with vacuum relay) will then be installed, completing the quiet QSK upgrade.

### Bias Relay Removal

The bias relay is located between the "RF Input" and "RF Output" SO-239 connectors as shown in Figure 2.11.

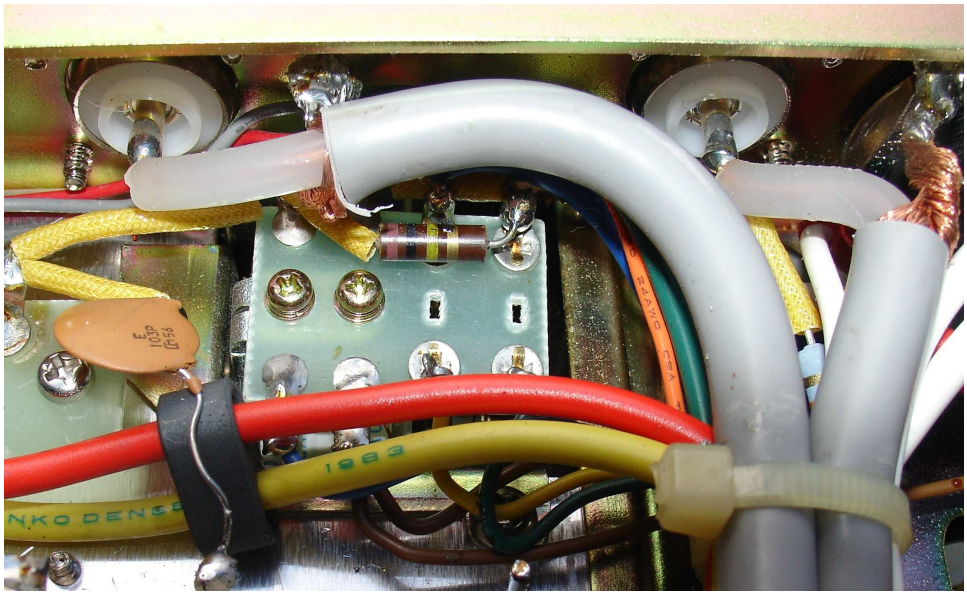

Figure 2.11: Bias Relay Prior to Removal

- Cut the plastic wire ties (or string-ties in older TL-922 amplifiers) holding the (grey) coaxial cables to the wiring harness.
- Do NOT remove the cathode drive (black coaxial cable).
- Cut and remove the stock grey coaxial cables near the SO-239 connectors.
- Remove all remnants of the grey coaxial cables and remove the solder from the SO-239 center pins, etc.
- Remove (and retain) the two metal screws holding the bias relay.

- Remove and discard the bias relay, lifting it upward and slightly forward, cutting each attached wire as necessary.

When finished, there should be a small rectangular opening in the chassis, located between the "RF Input" and "RF Output" SO-239 connectors as shown in Figure 2.12.

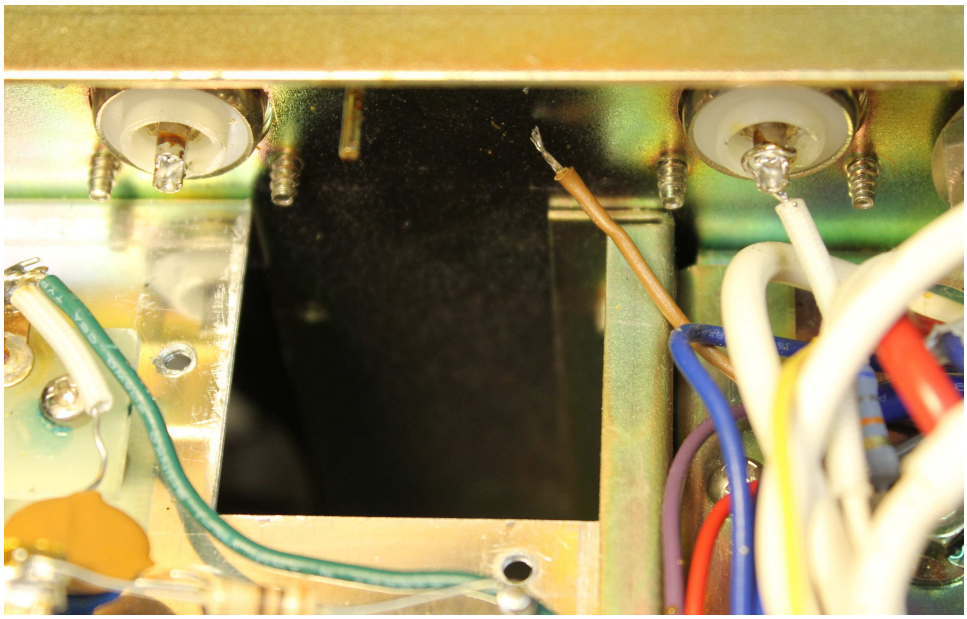

Figure 2.12: After Bias Relay Removal

The QSK T/R Relay PCB has a board-mounted male two-pin connector. This connector mates with a corresponding female two-pin connector – One wire is yellow and connects directly to the 10-pin Bias PCB connector – One wire is brown and needs to be soldered to the High-Voltage transformers' "TH-1" terminal (visible in Figure 2.10).

- Follow the #22 brown wire shown in Figure 2.12 and de-solder it from the High-Voltage transformers' "TH-1" terminal.
- Solder the brown wire emanating from the female two-pin connector to the "TH-1" connection on the High-Voltage transformer. *NOTE:* This brown "TH-1" wire should be routed near the chassis since this makes the final wire harness lash-up much neater.
- Orient and place the QSK T/R Relay PCB over the chassis opening.
- Fasten securely with two metal screws.
- Solder the exposed leads from the QSK T/R Relay PCB to the "RF Input" and "RF Output" SO-239 connectors.

- Solder the coaxial cable shield to the ground post near the "RF Output" SO-239 connector.

When finished, the installed QSK T/R Relay PCB should look as shown in Figure 2.13.

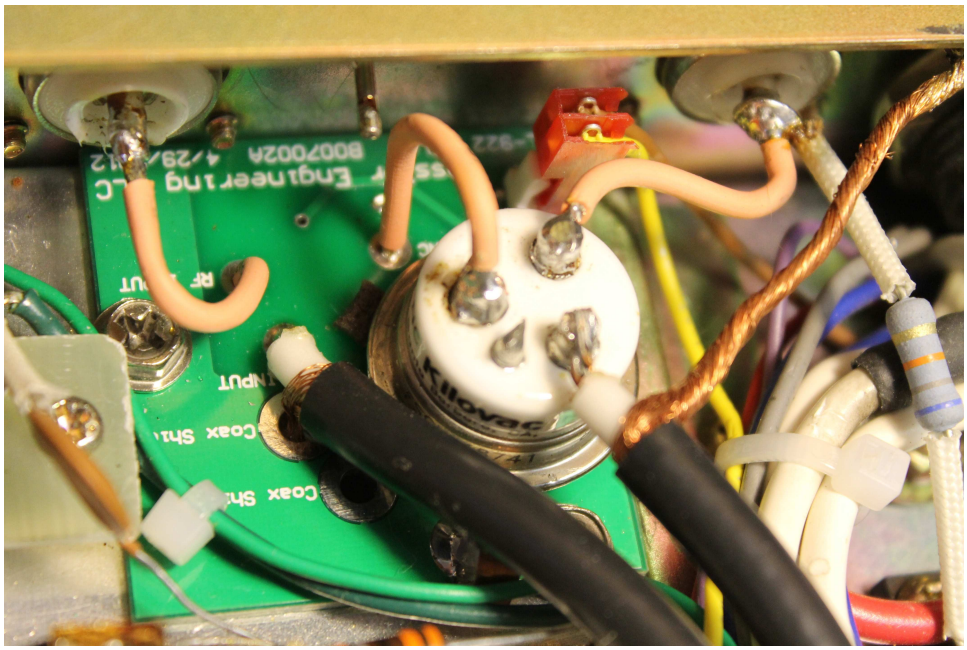

Figure 2.13: QSK T/R Relay PCB Installed

### 2.7.1 Stock T/R Relay Removal

The stock T/R relay is adjacent to the tuned input section as shown in Figure 2.14, and held in-place by two screws, accessible from the top-side of the amplifier, through the RF Deck. The RF choke shown in Figure 2.14 will be re-used.

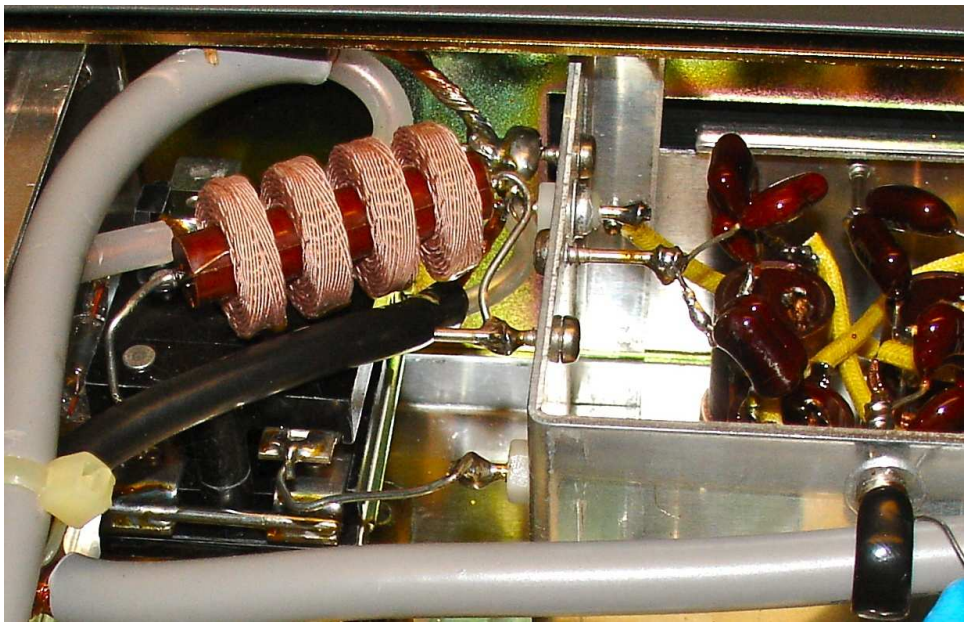

Figure 2.14: Stock T/R Relay Prior to Removal

- Carefully unsolder and remove the RF choke (it will be reinstalled later).
- Remove the two screws holding the T/R relay.
- Cut any wires where they connect to the relay and discard the stock T/R relay.
- Remove any remnants of the original grey coaxial cables.
- Clean all excess solder and residue from the ground posts and post feeding the tuned input.
- Remove the right side panel to complete this process.

At this point, the amplifier should appear as shown in Figure 2.15.

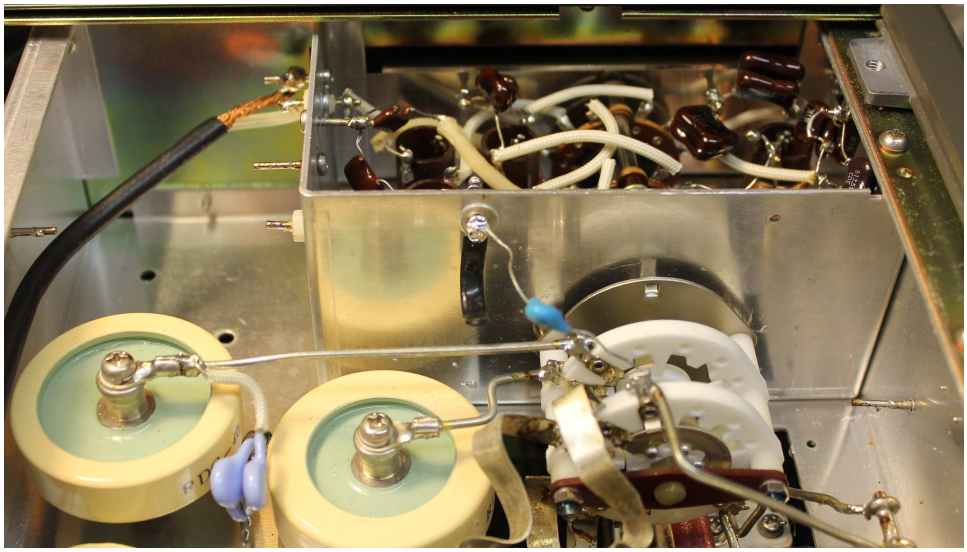

Figure 2.15: Amplifier after T/R Relay Removal

Two coaxial cables emanate from the QSK T/R Relay PCB. The shorter coaxial cable provides RF drive to the amplifier and must be connected to the amplifier's tuned input network. Refer to Figure 2.16 on page 20:

- Solder the shorter coaxial cable's braid to the ground post near the tuned input connector.
- Attach the coaxial cable center conductor to the tuned input post (Do NOT melt the nylon insulation).

The completed tuned input connections should appear as shown in Figure 2.16.

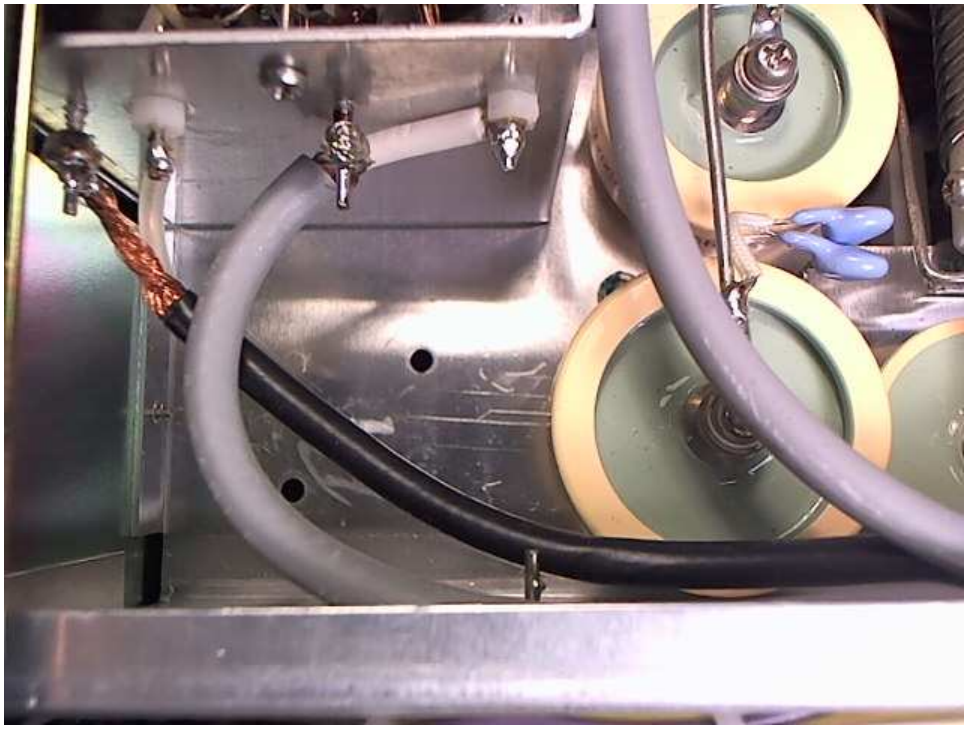

Figure 2.16: QSK PCB to Tuned Input Connections

The remaining coaxial cable provides the RF output signal path from the amplifier's load network to the QSK T/R Relay PCB.

- Solder the longer coaxial cable's shield to the ground post on the side of the amplifier, near the output band switch.
- Solder the coaxial center conductor to the RF output. (Near the bottom of the load capacitor as shown in Figure 2.17).
- Solder one end of the RF Choke to the ground post on the side of the amplifier, near the output band switch. This is the same post that the coaxial cable shield is soldered to.
- Solder the free end of the RF choke to the "common" contact of the output bandswitch as shown in Figure 2.18. The common connection will already have a bus wire running from the RF tank coil and will also 47pF capacitor shunt to ground.

When finished the amplifier should appear as shown in Figure 2.19.

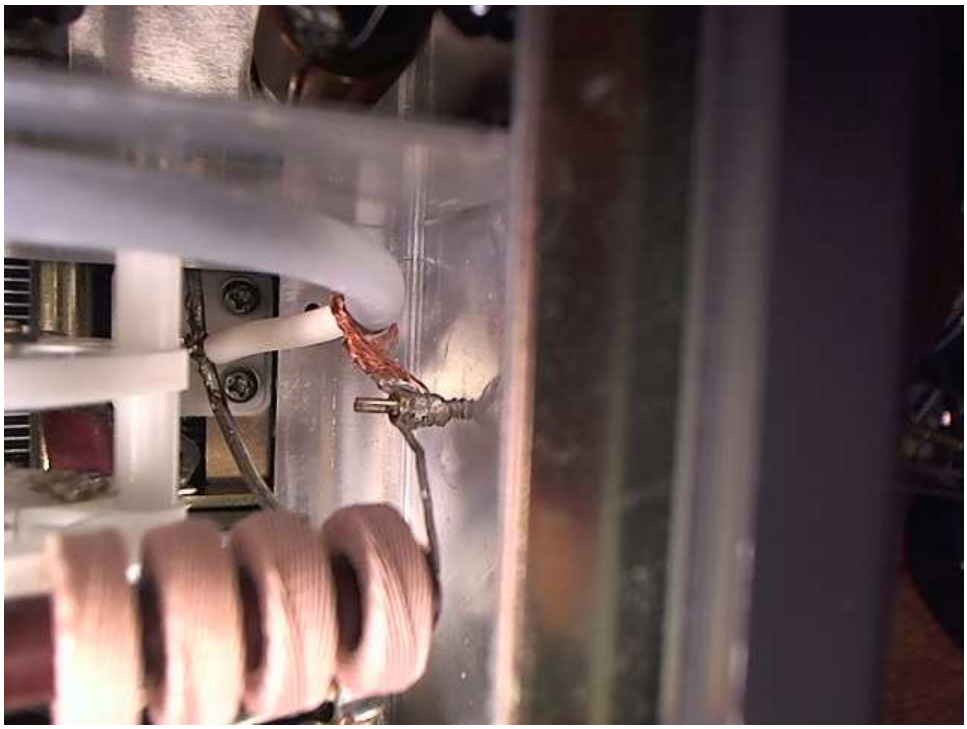

Figure 2.17: QRO Output to Coax Connection

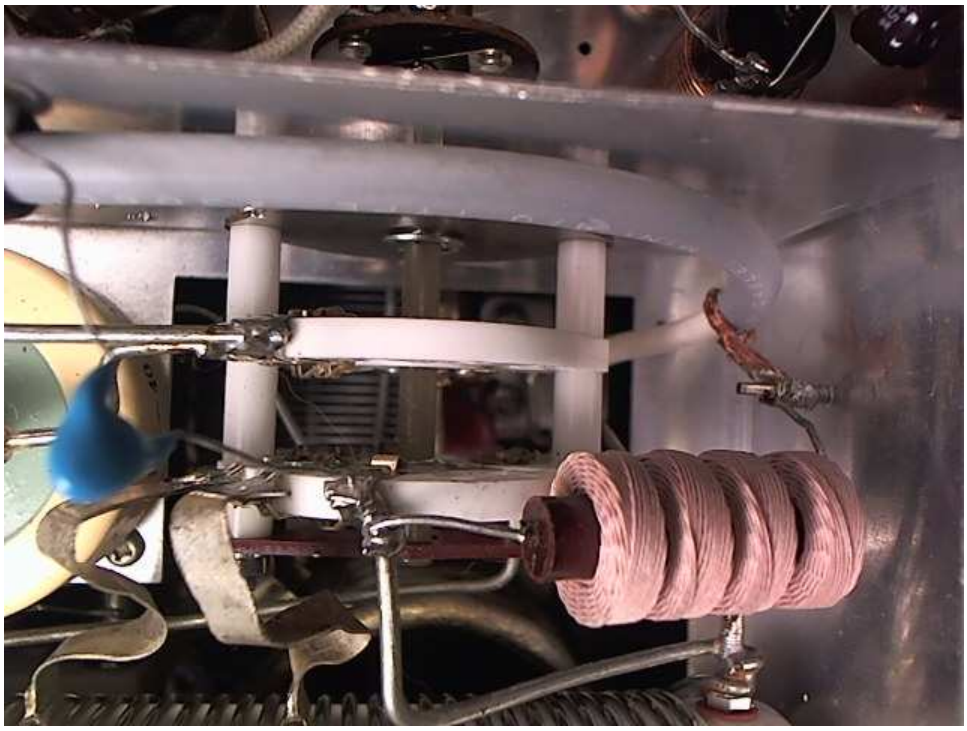

Figure 2.18: RF Choke to Bandswitch Connection

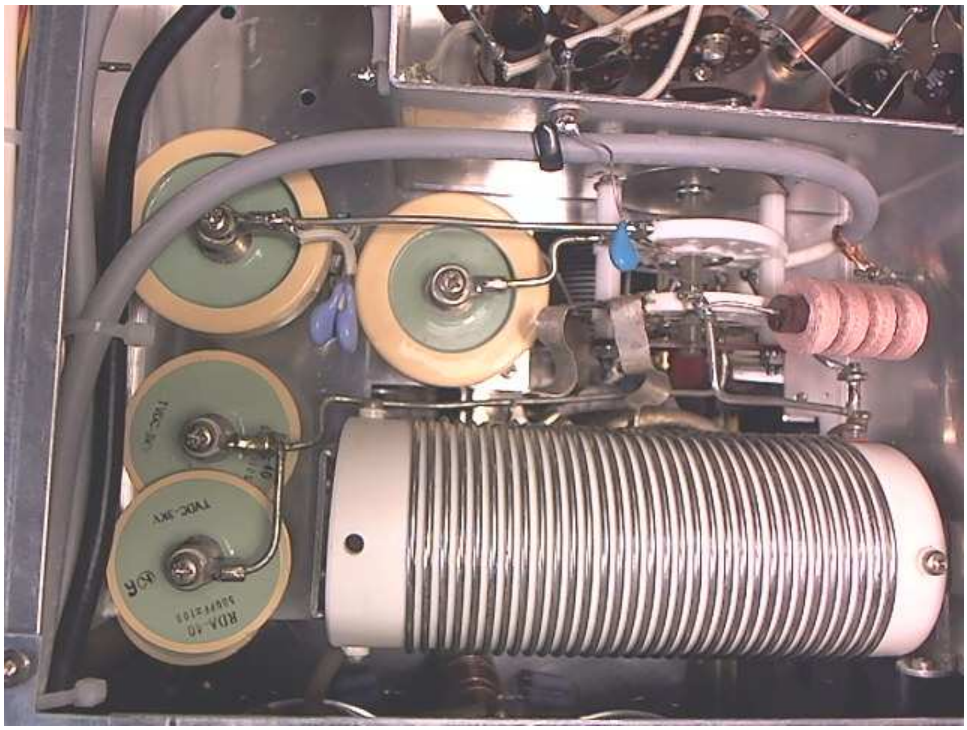

Figure 2.19: QSK PCB to QRO Output Connections

## 2.8 Electronic Bias PCB Installation

**Synopsis**

The amplifier's Zener bias diode and heatsink will be removed. The Electronic Bias PCB will be installed and new connections will be made to the filament transformer and the primary control PCB.

### 2.8.1 Zener Diode and Heatsink Removal

The stock Zener diode and its associated heatsink are located adjacent to the filament transformer as shown in Figure 2.20. This area will be used to hold the Electronic Bias PCB.

Figure 2.20: Zener Bias Diode Prior to Removal

- Cut the brown wire where it attaches to the Zener diode. This is the **IG** connection (described subsequently).
- Remove and retain the screws holding the heatsink to the chassis.
- Remove and retain the screw holding the terminal strip next to the Zener diode.
- De-solder the diode from the ground post.
- Remove the electrolytic capacitor and terminal strip located to the right of the filament transformer in Figure 2.20.

- Remove the ground post near the filament transformer.

  If unable to remove, then snap off the ground post as close as possible to the chassis ($\frac{1}{8}$“ max height).

- Remove all wires connected to the Filament Transformer's 8V and 80V windings.

- Do NOT remove either the #14 yellow wire or the #14 red wire shown in the upper portion of Figure 2.20. These two wires supply filament current to the tubes and must not be removed unless performing the filament voltage modification (not part of the TL-922 Revival kit). However, Figure 2.21 does show how the filament supply leads might appear if they were replaced during the filament voltage modification.

- Add a 0.01uF capacitor between the filament transformer “C.T.” (Center-Tap) and “E” (Ground) terminals. Ensure that the stock green wire remains soldered to the transformer “C.T.”

The filament transformer and area immediately adjacent should now appear as shown in Figure 2.21.

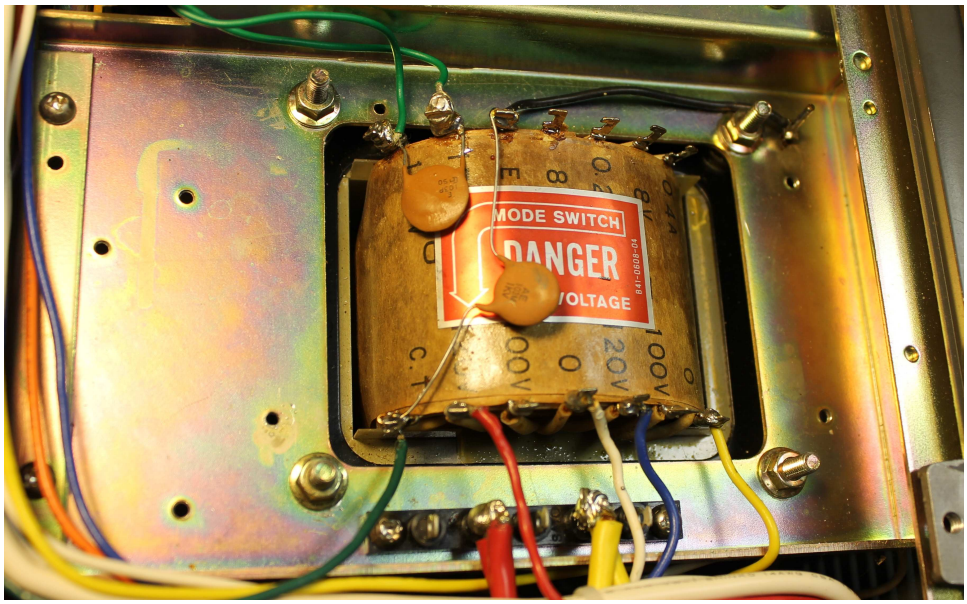


Figure 2.21: Amplifier Chassis After Zener Bias Diode Removal

### 2.8.2 Electronic Bias PCB Installation

The Electronic Bias PCB will be installed in the area formerly occupied by the Zener diode and heatsink, and will mount directly to the filament transformer. Refer to Figure 2.22.

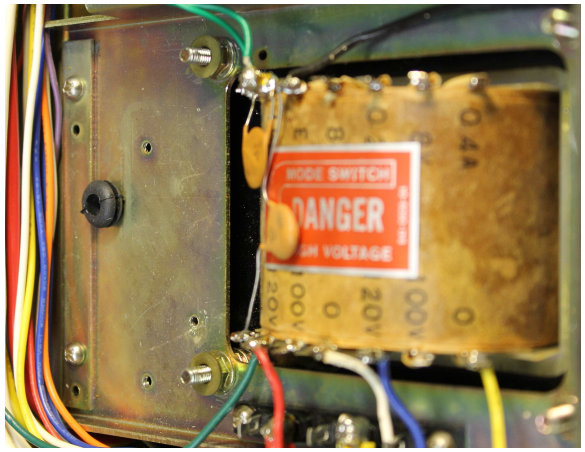


Figure 2.22: PCB Installation Preparation

- Place a flat washer on each of the two threaded posts nearest to the filament transformer.
- Place the rubber grommet as shown (it will be compressed and held in-place by the Electronic Bias PCB).
- Orient the Electronic Bias PCB and lower onto the filament transformer mounting bolts.
- Place a flat washer and #8 metric nut on the two mounting bolts and tighten.
- Plug in the LED PCB, Step-Start PCB, and the QSK Relay PCB (attached to 10-pin connector).

When finished, the amplifier should appear as shown in Figure 2.23. The connections to the 10-pin plug will be described next.

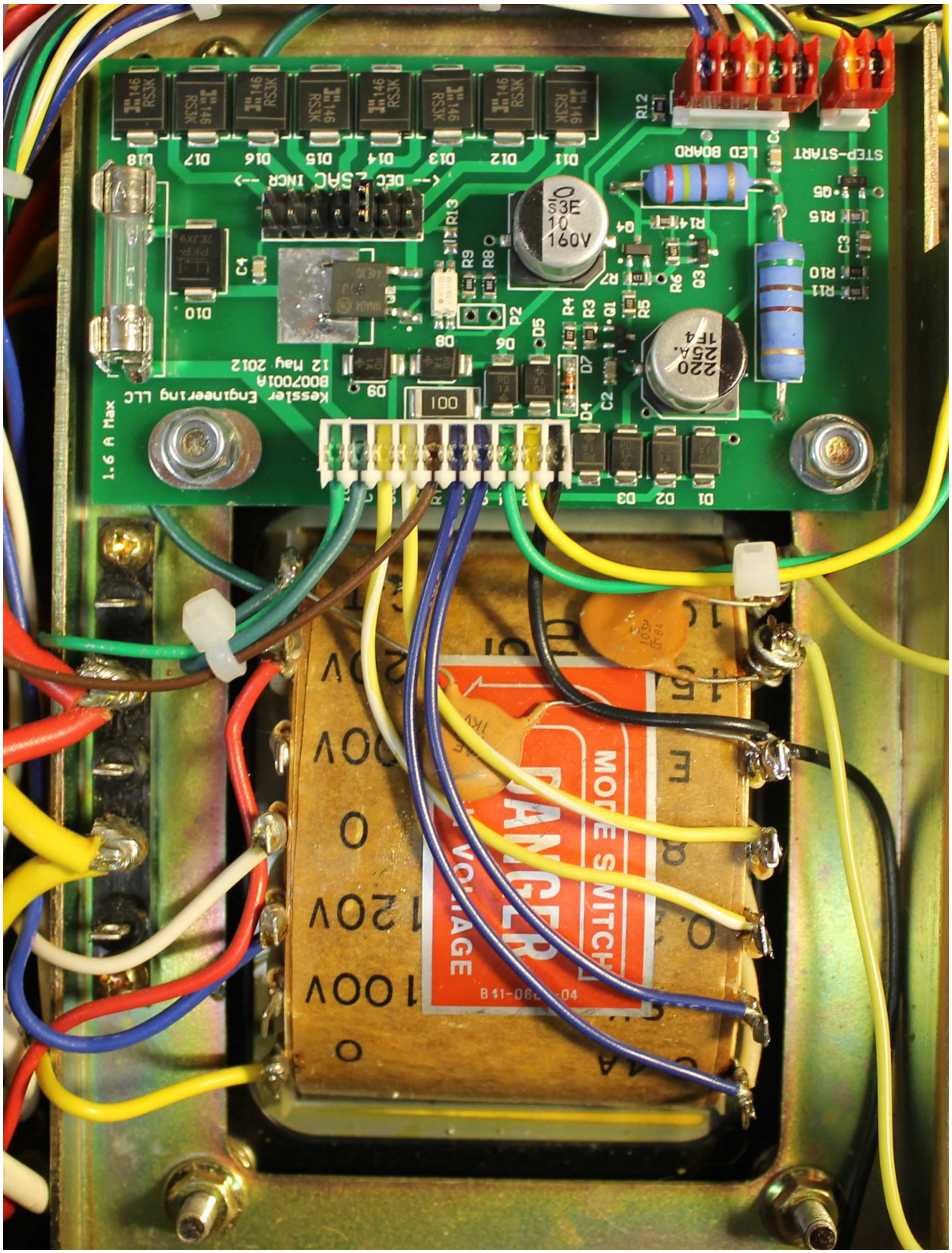


Figure 2.23: Electronic Bias PCB Installed

### 2.8.3 Electronic Bias PCB Connections

See Figure 2.23. The 10-pin connector provides the following (from left to right):

- **IG** – The grid bias control connection.
- **CT** – Filament transformer center-tap.
- **80V** – Filament transformer 80V output winding.
- **80V** – Filament transformer 80V output winding.
- **RY+** – Standby - Operate switch contact (Figure 2.25).
- **8V** – Filament transformer 8V output winding.
- **8V** – Filament transformer 8V output winding.
- **TX** – PTT control. RCA jack labeled "RL CONT".
- **RY-** – QSK Relay PCB (already connected).
- **GND** – Chassis ground connection.

### 2.8.4 IG Electrical Connection

The brown **IG** wire will be used to pull the Electronic Bias **IG** wire into position.

- Locate and follow the "Brown" wire (disconnected from the Zener bias diode).
- Temporarily solder the 10-pin connector's **IG** (green) lead to the "Brown" wire.
- Disconnect the "Brown" wire from the amplifier's control board **IG** post (Figure 2.24).
- Using the "Brown" wire, pull the Electronic Bias (green) **IG** lead into position.
- Solder Electronic Bias (green) **IG** lead to the control board **IG** post.

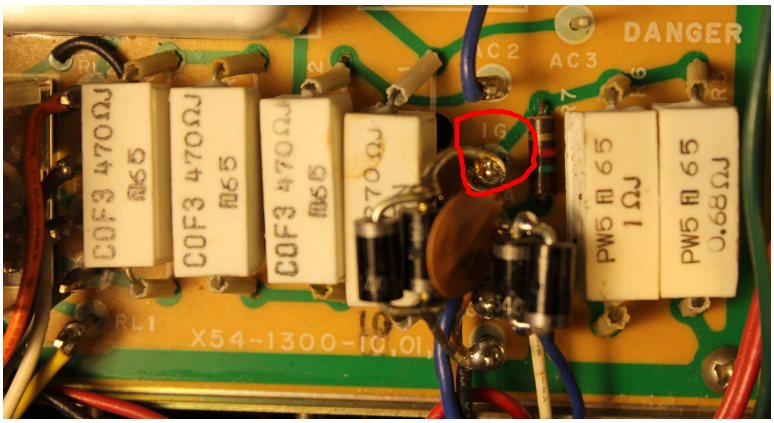


Figure 2.24: Amplifier **IG** connection

### CT Electrical Connection

- Solder the **CT** wire lead to the filament transformer **CT** terminal.

### 80V Winding Electrical Connections

The filament transformer 80V secondary winding feeds a full-wave bridge rectifier DC power supply used to power the QSK T/R relays. The label for the 80V winding may be partially obscured by the transformer warning label. However, the 80V windings are the two terminals shown on the right side of the transformer just below the **E** (Ground) terminal (Figure 2.23).

- Solder the first **80V** wire to the 80V terminal labeled "0" on filament transformer.
- Solder the second **80V** wire to the 80V terminal labeled "80V" on filament transformer.

### RY+ Electrical Connection

The **RY+** lead connects to the Standby-Operate switch. Refer to Figure 2.25.

- Unsolder and remove the wire (typically grey) from the forward terminal of the Standby-Operate switch. This terminal is shown circled in red in Figure 2.25.
- Solder the **RY+** lead to the Standby-Operate switch.

### 8V Winding Electrical Connections

The filament transformer 8V secondary winding feeds a low-voltage full-wave bridge rectifier DC power supply used to power the illumination and status LEDs as well as the bias control circuitry. As mentioned previously, the label for the 8V winding may be partially obscured by the transformer warning label. However, the 8V windings are the two terminals shown on the right side of the transformer farthest from the bias PCB.

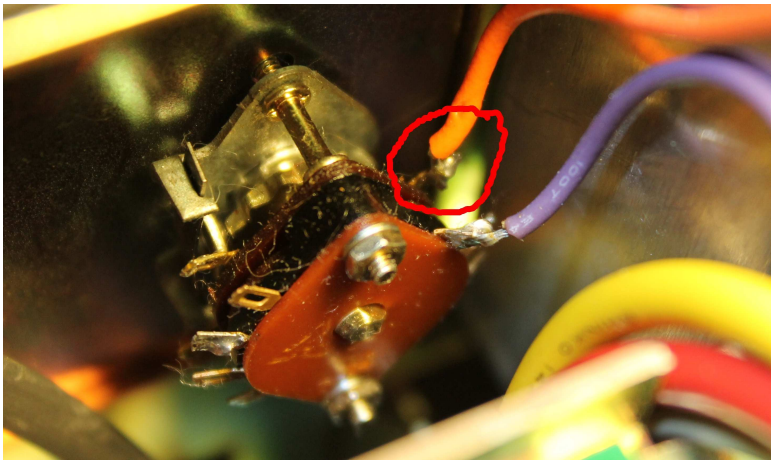

Figure 2.25: Standby-Operate Switch **RY+** connection

- Solder the first **8V** wire to the 8V terminal labeled "0.4A" on filament transformer.
- Solder the second **8V** wire to the 8V terminal labeled "8V" on filament transformer.

### TX Electrical Connection

The **TX** wire is the amplifier keying control input and must be connected to the amplifier "RL CONT" jack.

- Unsolder and remove the stock wire and capacitor from the RCA jack labeled "RL CONT".
- Route the **TX** wire and solder it to the center pin of the "RL CONT" RCA jack. See Figure 2.26

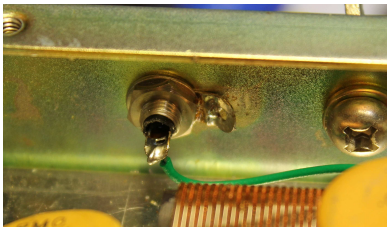

Figure 2.26: "RL CONT" to **TX** connection

### RY- Electrical Connection

The **RY-** provides electrical current to the QSK T/R Relays. This wire is already soldered to the QSK T/R Relay PCB **RY-** terminal.

### GND Electrical Connection

- Solder the **GND** lead to the filament transformer **E** (ground) terminal.

The filament transformer and Electronic Bias PCB should appear as shown in Figure 2.23 on page 26.

### 2.8.5 Electrical Checkout

Now that the hardware upgrade steps have been completed, inspect the amplifier very closely and remove any remaining debris and wire remnants, etc. At this point, the amplifier should appear as shown in Figure 2.27. (NOTE: This Figure shows an additional modification to lower the filament voltage, a modification to the grid circuitry, as well as modification to the cathode drive – not included in this modification kit).

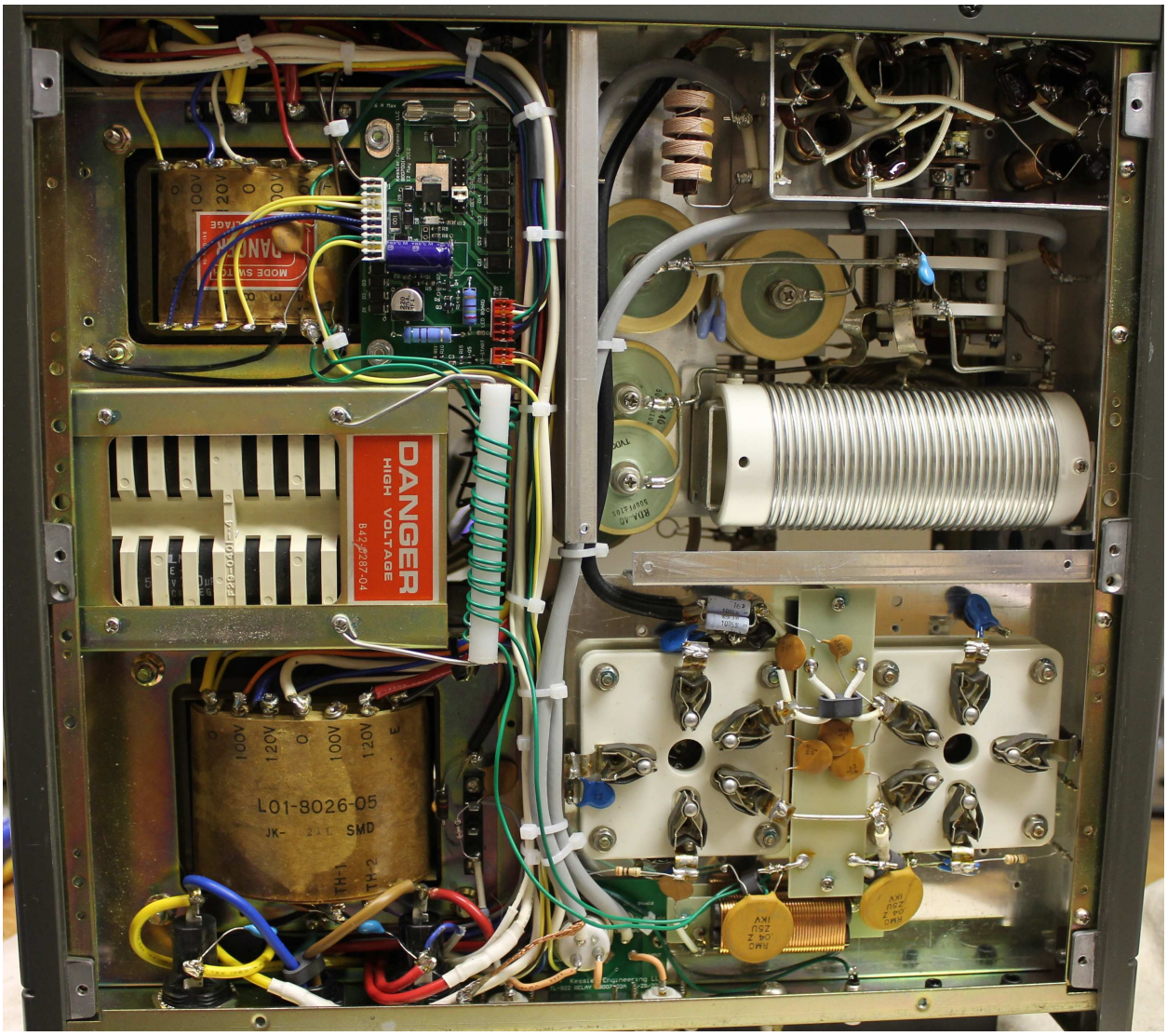


Figure 2.27: Complete Installation of QSK, Electronic Bias, and Step-Start

**Synopsis**

Checkout of the modified amplifier will be performed in a series of stages. For each of these steps, AC mains electrical power will be applied to the amplifier. However, It is *IMPERATIVE* that all safety precautions be observed due to the presence of lethal voltages! DO NOT TOUCH ANYTHING within the amplifier while it is plugged into the AC mains or whenever High-Voltage is present, such as from the anode High-Voltage power supply!!!

1. Ensure the top outer cover is removed from the amplifier (this should ensure the HV transformer will not be energized).
2. Place the amplifier upside-down on the workbench.
3. Install the AC mains fuses.
4. Place the amplifier "POWER" switch to the **OFF** position.
5. Set the amplifier "METER" switch to the **HV** position.
6. Set the amplifier "LINEAR" switch to the **STBY** position.

**Step-Start and LED Checkout**

This test will confirm correct operation of the Step-Start circuit as well as the proper sequencing of the **ON AIR** and **STBY** lights.

Whenever the amplifier is switched **On**, the AC mains current flow is limited briefly by the two power resistors on the Step-Start PCB. After a brief interval (approximately 2 seconds), the Electronic Bias PCB circuitry will energize the Step-Start Relays, causing the relays to close, no longer restricting input current. When this occurs, the meter illumination will increase in brightness and the user should hear the relays close. All of this should occur within the first 2-3 seconds of operation. If the Step-Start Relays do not close within this interval, it indicates a problem that must be solved before proceeding.

Whenever the amplifier outer top cover is removed, the High-Voltage transformer and the cooling fan are unpowered. If tubes are installed in the amplifier during these tests, the user should limit *On-Time* since cooling airflow will not be present. Read through the following steps before actually performing them. If any problems are noted, switch the amplifier **OFF**, then unplug from the AC mains.

1. Ensure the amplifier "POWER" switch is in the **OFF** position.
2. Plug the amplifier into the AC mains.
3. While observing the front of the amplifier, switch the amplifier **ON**.

4. Confirm both meters are illuminated.

5. Confirm operation of the Step-Start Relay (Within 1-2 seconds after switching the amplifier **ON**, the Step-Start Relay should produce a soft "Click" and the meter illumination should noticeably brighten).

6. After approximately 20 Seconds, switch the amplifier "POWER" switch **OFF**.

If the amplifier Step-Start Relay energized properly and the meters illuminated, then brightened after the Step-Start interval, proceed with the following test. Otherwise, unplug the amplifier from the AC mains and begin troubleshooting.

1. Insert the amplifier keying line into the "RL CONT" jack.

2. Ensure the free-end of the keying line is electrically "Open".

3. Switch the amplifier **ON** and reconfirm proper Step-Start operation.

4. Confirm that neither **ON AIR** nor **STBY** lights is illuminated.

5. Change the amplifier "LINEAR" switch from **STBY** to **OPERATE**.

   Confirm the **STBY** light is now illuminated.

6. Electrically short the "Open" end of the keying line.

   Confirm the **STBY** light is extinguished and **ON AIR** light is illuminated.

7. Set the "LINEAR" switch to **STBY**.

   Confirm **STBY** and **ON AIR** lights are extinguished.

8. Set the "LINEAR" switch to **OPERATE**, and short the keying line.

   Confirm the **STBY** light is extinguished and **ON AIR** light is illuminated.

9. Open the keying line.

   Confirm **ON AIR** light extinguished and **STBY** light illuminated.

10. Electrically short the "Open" end of the keying line (again).

    Reconfirm the **STBY** light is extinguished and **ON AIR** light is illuminated.

11. With the keying line still shorted, set the "LINEAR" switch to **STBY**.

    Confirm **STBY** and **ON AIR** lights are extinguished.

12. Leave the "LINEAR" switch set to **STBY**.

13. Switch the amplifier **OFF**.

If the lamp sequencing works correctly, then proceed with the next test to confirm switching operation of the QSK T/R Relay. For this test, we recommend using an audible continuity tester.

1. Connect one lead of the continuity tester to the center pin of the SO-239 "RF INPUT" jack.

2. Connect the other lead of the continuity tester to the center pin of the SO-239 "RF OUTPUT" jack.

   Confirm DC continuity between the center pins of the "RF INPUT" and "RF OUTPUT" connectors.

3. Set the "LINEAR" switch to **OPERATE**.

4. Open the keying line.

5. Switch the amplifier **ON**.

   Confirm DC continuity between the center pins of the "RF INPUT" and "RF OUTPUT" connectors.

6. Electrically short the "Open" end of the keying line cable.

   Confirm loss of DC continuity between the center pins of the "RF INPUT" and "RF OUTPUT" connectors.

7. Measure DC resistance between center pin and ground of the SO-239 "RF INPUT" jack, while the **ON AIR** light is illuminated.

   Confirm DC resistance less than approximately 20Ω (8-15Ω typical).

### Electronic Bias Adjustment and Checkout

This test confirms correct operation of the High Voltage Power Supply and Electronic Bias.

***LETHAL*** voltages will be present within the amplifier during these tests!!

***ALL AMPLIFIER COVERS MUST BE IN-PLACE DURING TEST!!***

.

Under normal conditions with a "healthy" set of 3-500Z tubes, the idling current should be approximately 180-200mA when operating with the "MODE" switch in the **SSB** position, whereas the idling current should be approximately 90-100mA when operating with the amplifier "MODE" switch set to the **CW** position. Idling current, also known as Zero-Signal Anode Current (ZSAC) is the anode current that flows when the tubes are biased **On** without RF drive signal. The RF exciter will not be attached to the amplifier for any of these tests.

The 3-500Z vacuum tubes may be operated upright or upside-down. However, the tubes may not be operated when oriented horizontally. The tests may only be performed with the amplifier either upright or upside-down.

The stock TL-922 featured a fixed, non-adjustable cathode bias (Zener diode). The Electronic Bias PCB includes adjustable bias. The bias is adjusted by setting a jumper to 1-of-7 possible bias settings. Moving the bias jumper closer to the front of the amplifier will increase ZSAC, while moving the jumper in the opposite direction will decrease ZSAC. ZSAC adjustment must NOT be attempted while the amplifier is operating or if plugged into the AC mains.

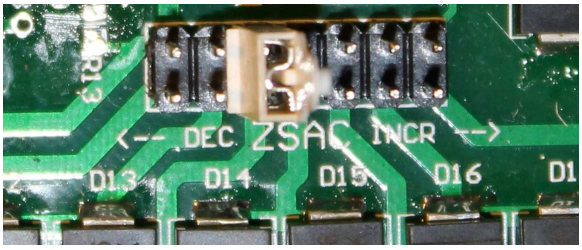


Figure 2.28: Electronic Bias ZSAC Adjustment Jumper

1. Unplug the amplifier from the AC mains.
2. Ensure both tubes are installed and that the anode VHF suppressors are properly connected to the tube anodes.
3. Install the amplifier top inner and outer covers.
4. Place the amplifier upside down.

5. Set the ZSAC control jumper as shown in Figure 2.28.
6. Install the amplifier bottom cover.
7. Ensure the amplifier is switched **OFF**.
8. Plug the amplifier into the AC mains.

The first portion of this test will re-confirm operation of the Step-Start and expected High-Voltage operation. When switched **ON**, the High-Voltage will begin to "ramp" up, then "plateau" until the Step-Start Relay is energized. At that moment, the High-Voltage should reach normal levels (approximately 2kV when "MODE" switch is set to **CW**, and approximately 3kV with "MODE" switch set to **SSB**).

1. Set the "MODE" switch to **CW**.
2. Set the "METER" switch to **HV**.
3. Set the "LINEAR" switch to **STBY**.
4. While observing the "HV" meter, switch the amplifier **ON**.

   Confirm Step-Start Operation.

   Confirm HV ramps up initially, plateau, then reaches approximately 2kV after Step-Start Relay activation.

   Confirm that there is no anode current (**IP** reads "0").
5. Switch the amplifier **OFF**.
6. Set the "MODE" switch to **SSB**.
7. While observing the "HV" meter, switch the amplifier **ON**.

   Confirm HV ramps up initially, plateau, then reaches approximately 3kV after Step-Start Relay activation.

   Confirm that there is no anode current (**IP** reads "0").
8. Switch the amplifier **OFF**.

The operation of the Electronic Bias will be confirmed.

1. Insert the amplifier keying line into the "RL CONT" jack.
2. Ensure the free-end of the keying line is electrically "Open".
3. While observing the "HV" meter, switch the amplifier **ON**

4. Set the "LINEAR" switch to **STBY**.

   Confirm illumination of the **STBY** light.

5. Electrically short the "Open" end of the keying line cable.

   Confirm **ON AIR** light illuminated, **STBY** light extinguished.

   Observe and note anode idling current (**IP**) for proper ZSAC level.

6. Open the keying line.

   Confirm that anode current returns to "0".

7. Switch the amplifier **OFF**.

If necessary, the idling current should be adjusted to achieve approximately 180mA ("MODE" switch to **SSB**). To do so, unplug the amplifier from the AC mains. Wait approximately 30 minutes for the HV to bleed off, then move the bias jumper in the appropriate direction to increase/decrease idling current. Secure the bottom cover, and repeat the previous test until proper idling current is achieved.

Congratulations!! If you've gotten to this point, passing all of the tests, then you've successfully upgraded your TL-922 with QSK, Step-Start, Electronic Bias, etc., and it should provide reliable service for years to come. Congratulations on a job well-done!

### 2.8.6 Electrical Schematics

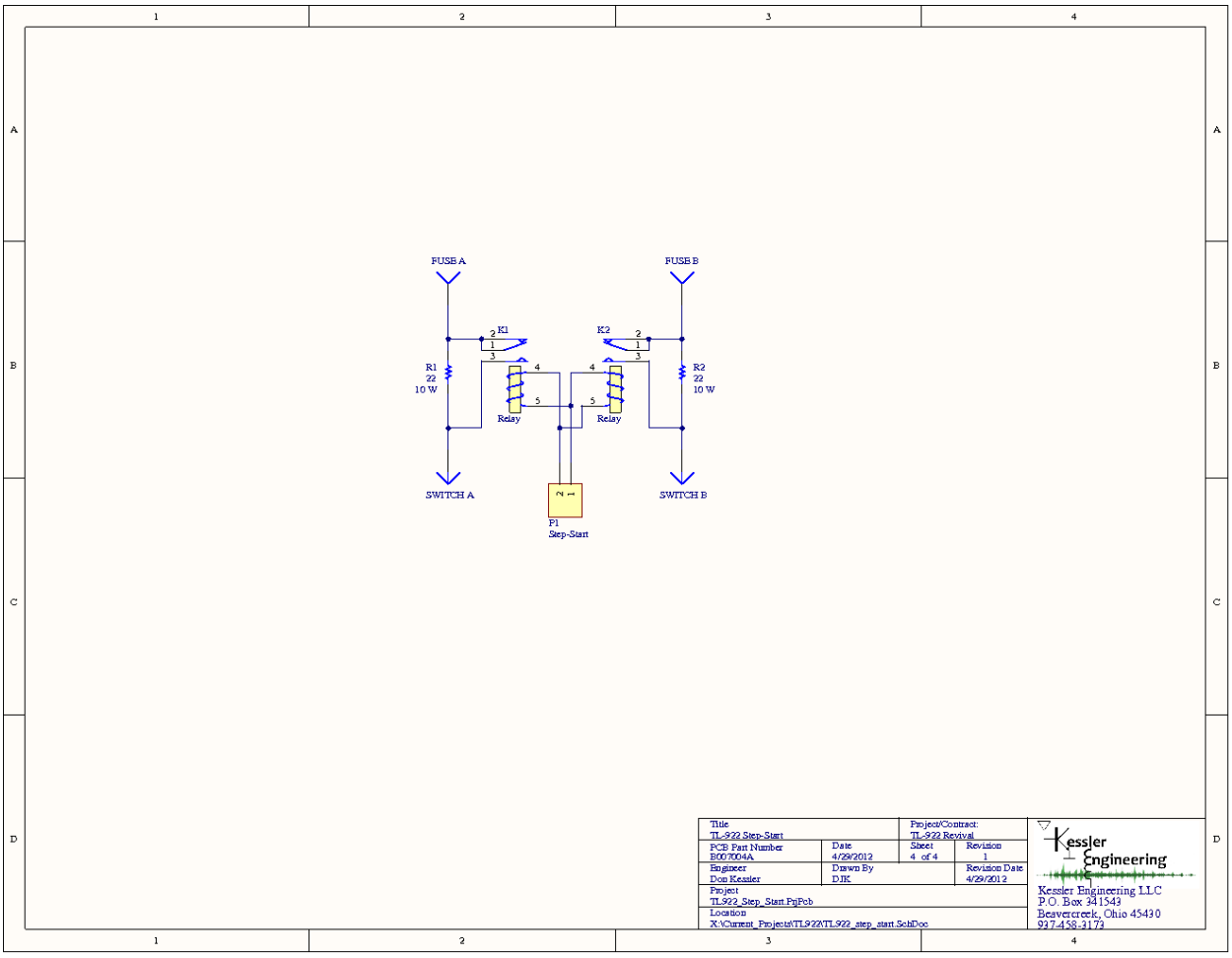


Figure 2.29: Step-Start Schematic Diagram

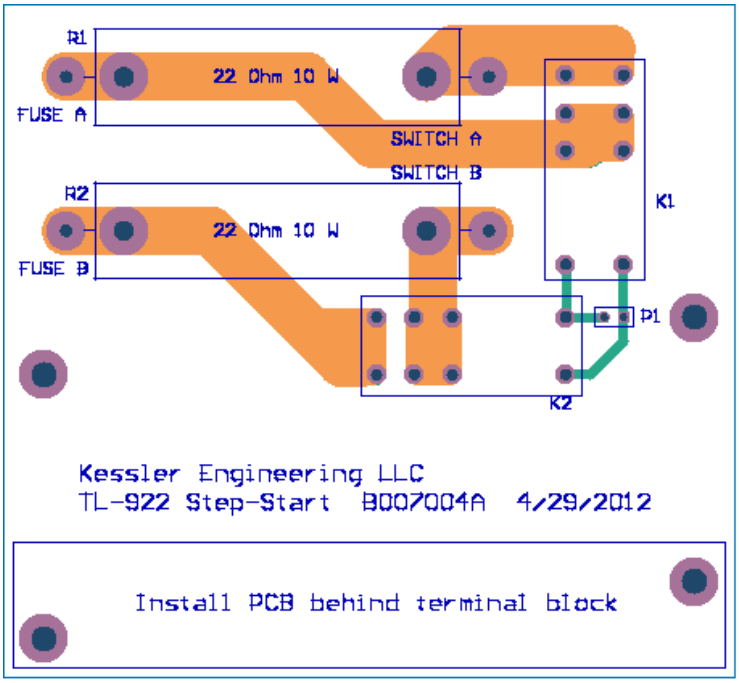


Figure 2.30: Step-Start PCB

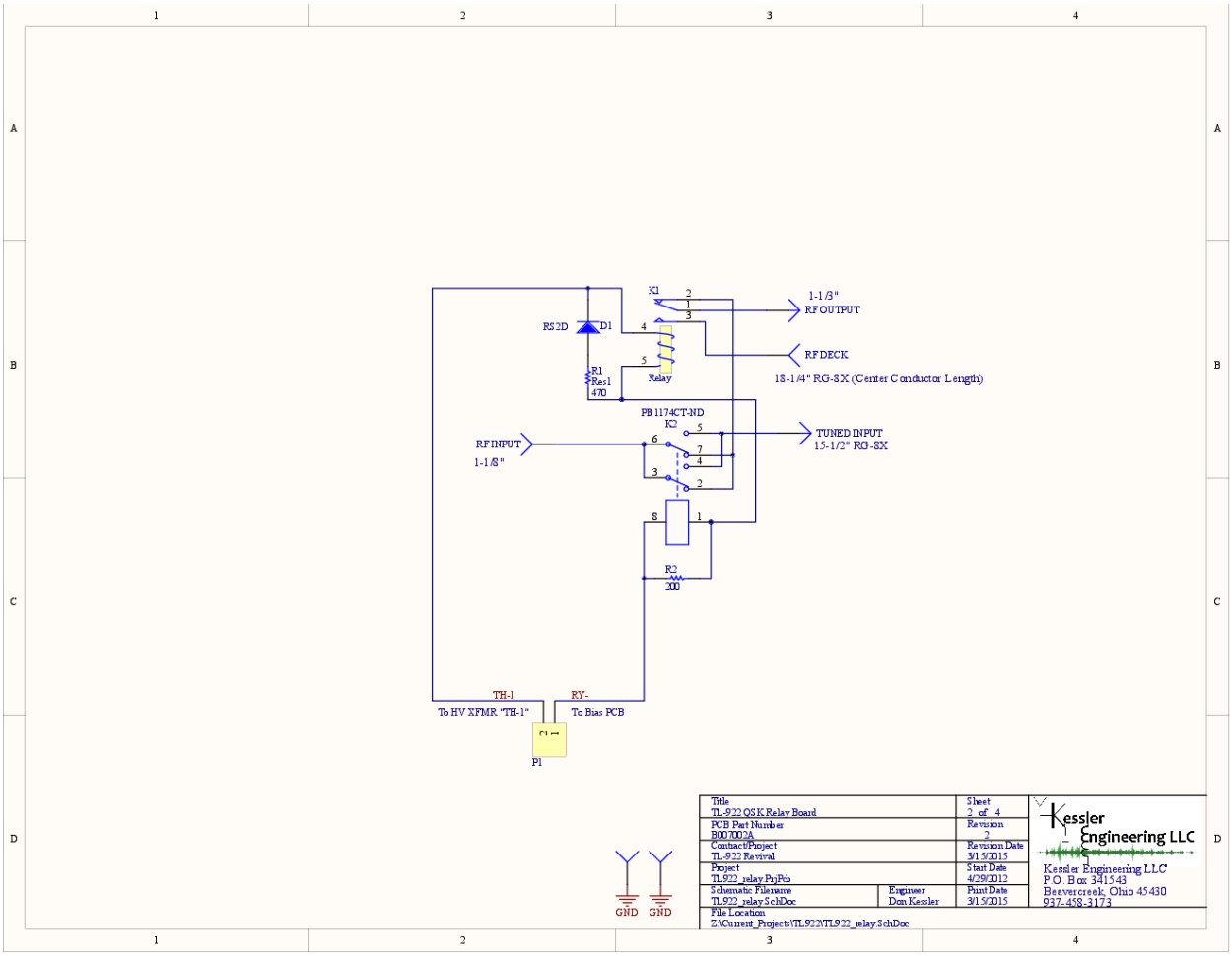


Figure 2.31: QSK T/R Relay Schematic Diagram

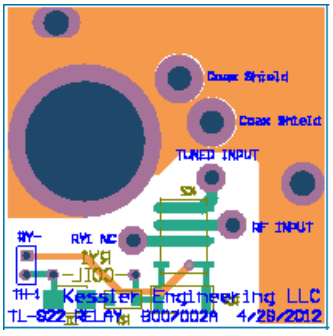


Figure 2.32: QSK T/R Relay PCB

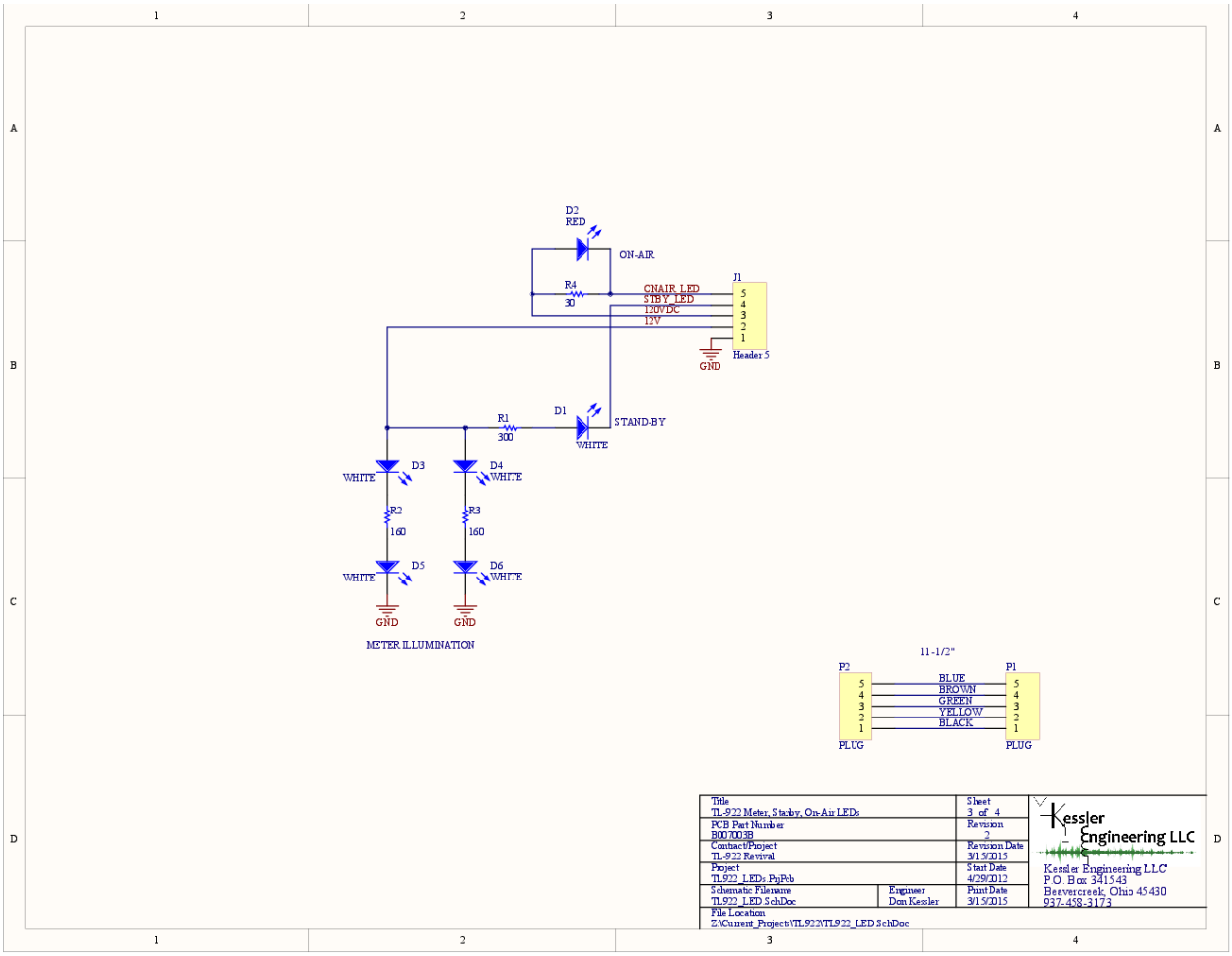


Figure 2.33: LED Schematic Diagram

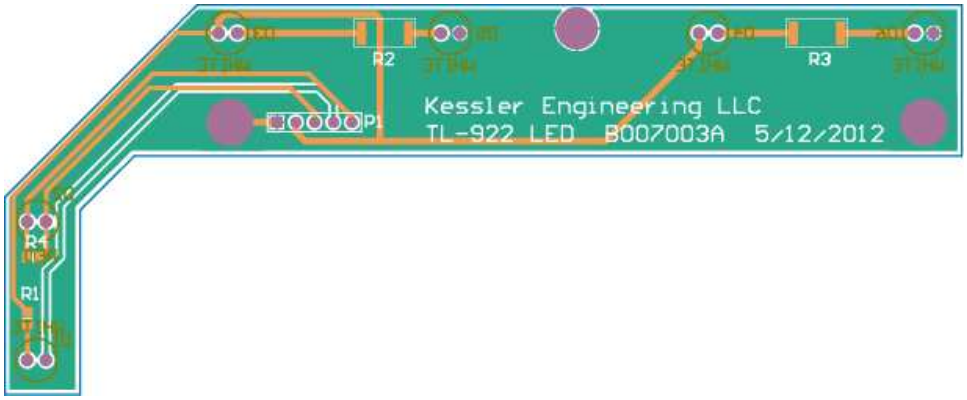


Figure 2.34: LED PCB

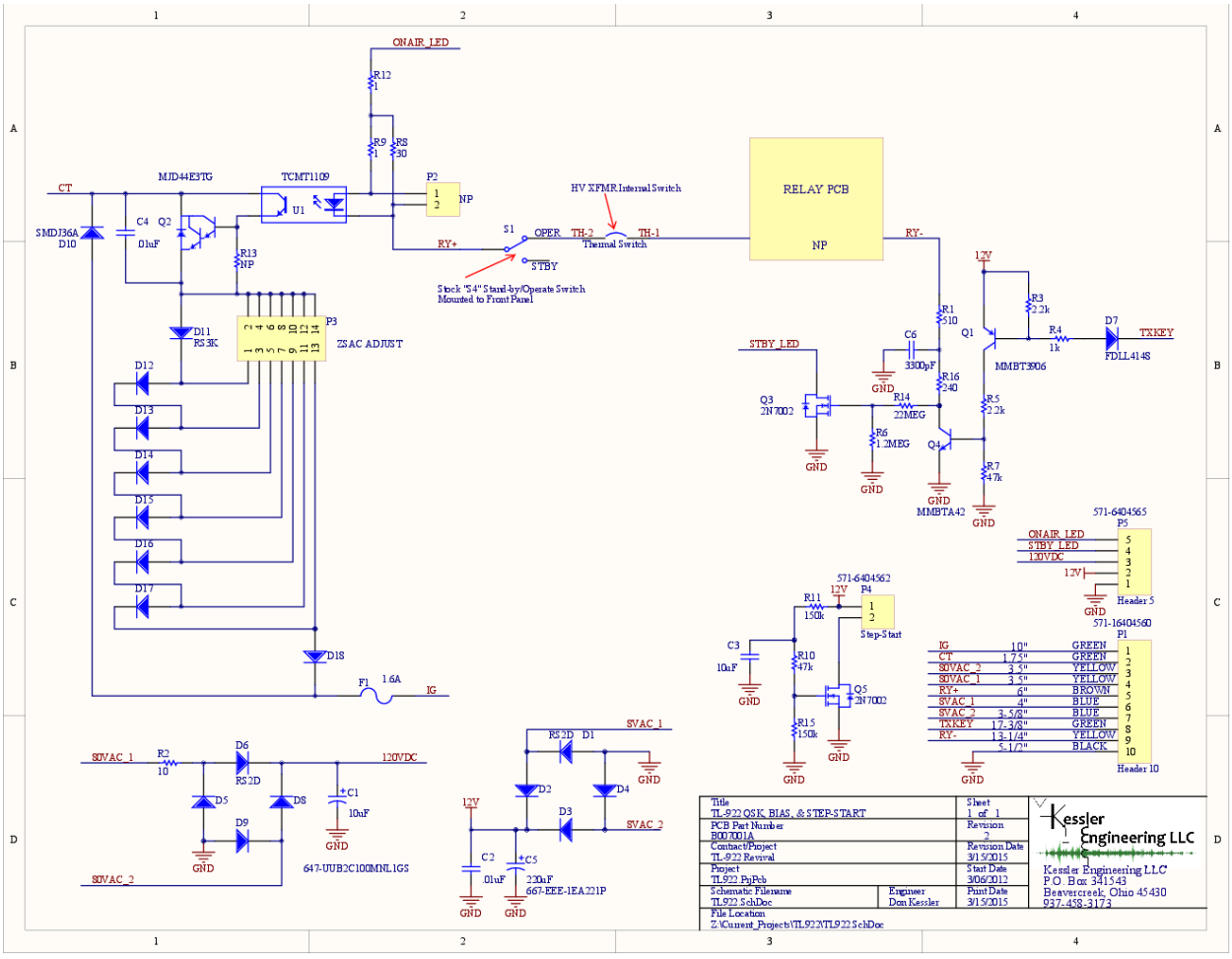


Figure 2.35: Electronic Bias Schematic Diagram

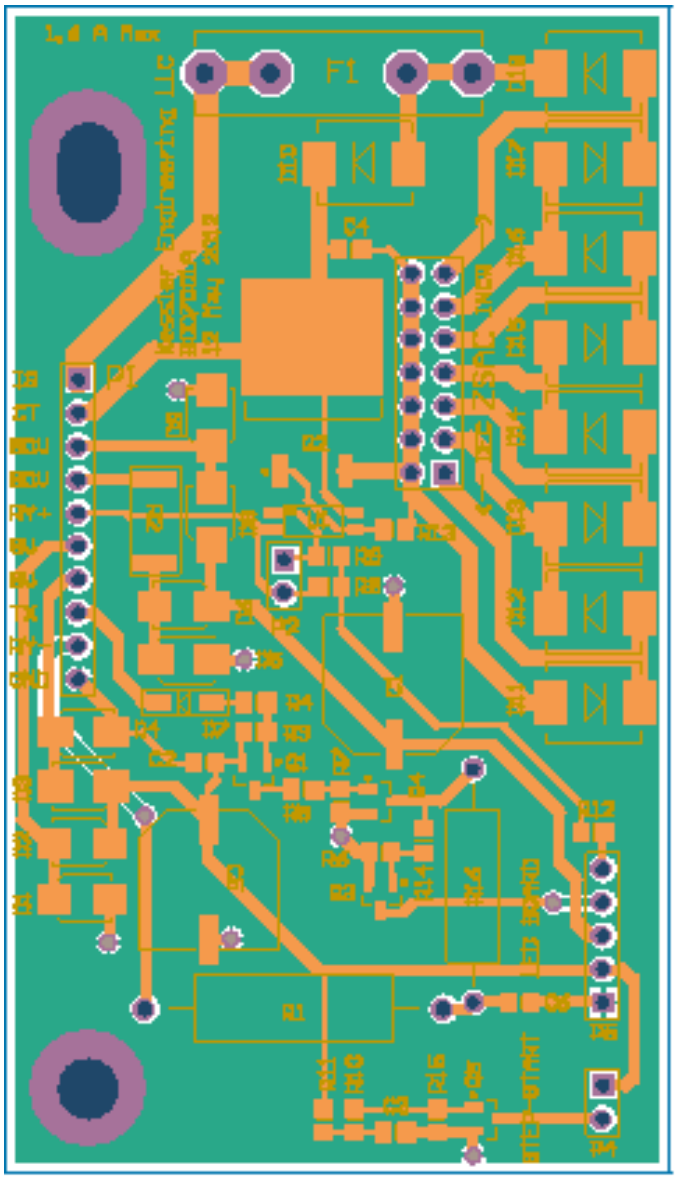

Figure 2.36: Electronic Bias PCB

# Service and Warranty

## Warranty

Kessler Engineering, LLC. warrants all of our products to be free from defects in material and workmanship under normal use for a period of one year from the date of purchase. During this one-year warranty period, Kessler Engineering will opt to either repair or replace the product.

This warranty will be void if the product has been repaired or altered by anyone other than the staff at Kessler Engineering. This warranty does not apply to products damaged due to improper installation or abuse/misuse.

## Repair Policy

Please contact our service department for return authorization and shipping instructions prior to sending any product for service or repair. All items shipped to Kessler Engineering, must be packed appropriately and insured against damage. Kessler Engineering is not responsible for merchandise damaged in shipment. Be sure to include a note describing the problem in detail and include your contact information (phone number and e-mail).

## Return Policy

All returns must receive prior authorization. Returned items must also include a copy of the original sales receipt and be returned with the original box, manuals, and accessories. Returns must be received within 7 days of purchase and are subject to a restocking fee. Shipping expenses are not refundable.

# Bibliography

[1] Kenwood Corporation, "Linear Amplifier Model TL-922A Instruction Manual," B50-2587-00 (G).

[2] Kenwood Corporation, "Service Manual TL-922 Linear Amplifier," B51-0835-00, April, 1994.

[3] Richard L. Measures, "Improving the Heathkit SB-220 Amplifier," *QST*, pp. 42, February 1989.

[4] Richard L. Measures, "Improving Amplifier Parasitic Suppression for Modern Amplifier Tubes," *QST*, pp. 36-38, 66, 89, October 1988.

[5] Richard L. Measures, "Circuit Improvements for the Heath SB-220 Amplifier – Part 1," *QST*, pp. 25-29, November 1990.

[6] Richard L. Measures, "Circuit Improvements for the Heath SB-220 Amplifier – Part 2," *QST*, pp. 41-43, December 1990.

[7] Richard L. Measures, "QSK for the TL-922 and SB-220 With Circuit Improvements for the TL-922," http://www.somis.org/QSK922.html, October 2004

[8] Richard L. Measures, http://www.somis.org/

[9] Richard L. Measures, "The Nearly Perfect Amplifier," *QST*, pp. 30-34, January 1994.

# User Notes

## 4.1 User Notes - Continued

## 4.2 User Notes - Continued

## 4.3 User Notes - Continued